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(54) **Polymer coating for low electrically conductive materials**

(57) A process for forming a coating of a thermoplastic polymer on a hollow object formed of a low electrically conductive material is described, characterised in that the thermoplastic polymer has its maximum IR absorption between 1300 and 1900 nm and/or 2800 and 3000 nm, is applied electrostatically as a powder to the object while the object is held at a temperature below the melting point of the thermoplastic polymer, and thereafter the object is heated by IR radiation to form the coating.

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Description

The present invention relates to a process for providing a hollow object formed of a low electrically conductive material with a coating of a thermoplastic polymer, and in a preferred embodiment, providing a glass or ceramic container with a coating of an ionic polymer.

Background of the invention

Polymer coatings are provided on objects having low electrical conductivity such as ceramics and glass for a variety of reasons such as for weight savings, shatter protection, aesthetics and touch. In particular, providing shatter protection to glass bottles containing carbonated beverages is of particular importance where the glass bottles are defective or mishandled.

Polymeric coatings can be applied by various means. The objects to be coated can be dipped into a polymeric melt or can be dipped into a fluidised bed of polymer powder particles. It is also known to coat objects using an electrostatic powder spraying process; c.f. US Patent No. 352,682, DE 2424220, DE 2750370 C2 and DE 2750372 C2.

DE 2750370 C2 and DE 2750372 C2 disclose electrostatic spray coating processes in which the substrate (a glass bottle) is maintained at a temperature below the melting point of the polymer, and the powder is applied by way of silent discharge. Afterwards, the bottle is heated to melt the powder to form a coating, which is subsequently cured. These processes, however, require high investment costs, can lead to corrosion of the equipment as they require continuous discharge, have limitations to the speed at which they can be carried out, require the use of very fine polymer powder which is expensive to produce, often produce non-uniform coatings due to local discharges at the bottle surface, and can be dangerous to carry out due to shattering of the bottles during heating and quenching steps.

These disadvantages are overcome by the current invention.

Detailed description of the current invention

The present invention provides a process for forming a coating of a thermoplastic polymer to a hollow object formed of a low electrically conductive material, characterised in that the thermoplastic polymer has its maximum IR absorption between 1300 and 1900 nm and/or 2800 and 3000 nm, is applied electrostatically as a powder to the object while the object is held at a temperature below the melting point of the thermoplastic polymer, and thereafter the object is heated by IR radiation to form the coating.

Advantages of the process include

- the hollow objects, e.g. glass bottles, can be taken

directly from the annealing ovens of the glass bottle plants, thereby avoiding the need for large, expensive to preheat the objects prior to coating;

- coating output is increased considerably;
- potentially dangerous electric discharge and vacuum equipment is not needed;
- more uniform coatings can be obtained using less expensive, larger particle size polymer.

As mentioned, suitable thermoplastic polymers to be used in the process according to the invention with have their maximum IR absorption between 1300 and 1900 nm and/or 2800 and 3000 nm. Preferred such polymers are ethylene/acid copolymers and ethylene/acid/acrylate terpolymers and their corresponding ionomers.

Ethylene/acid copolymers and their corresponding ionomers are well known in the art to be copolymers of ethylene with an olefinically unsaturated organic acid such as acrylic or methacrylic acid, the acid comprising about 1 to 50 mole percent of the total polymeric material. The ethylene/acid copolymers and their methods of preparation are well known in the art and are disclosed in, for example US. Pat. Nos. 3,264,272, 3,404,134, 3,355,319 and 4,321,337. The copolymers are termed ionomers when the acid is neutralized in whole or in part, preferably up to 80 % to produce a salt. The cation for said salts may be a metal ion chosen from the first, second or third group of the periodic table of elements, and is preferably an alkali metals such as sodium, potassium or zinc.

Ethylene/acid/acrylate terpolymers and corresponding ionomers are well known in the art to be terpolymers of the aforementioned ethylene and olefinically unsaturated organic acids, together with an alkyl acrylate or methacrylate (e.g. ethylacrylate, n-butyl acrylate, isobutylacrylate or methacrylate). The terpolymers will typically contain between 1 and 40 weight % of alkyl acrylate or methacrylate, 1 and 50 weight % unsaturated organic acid and 50 and 98 weight % ethylene.

Preferred ionomers are copolymers of ethylene and 1 to 50%, more preferably 5 to 25%, by weight acrylic or methacrylic acid neutralized up to about 90%, more preferably from 5 to 60% with an alkali metal ion or a divalent or trivalent metal ion, the melt index of the copolymer, whether neutralized or unneutralized, being about 0.1 to 30, preferably 0.5 to 20, dg/min. according to ASTM Standard D1238 (condition E).

Suitable acid copolymers and ionomers are available from the DuPont Company under the trade names Nucrel® and Surlyn®, respectively, and are generally described US Patent Nos. 3,264,272 and 4,351,931.

~~The foregoing process produces a coating on the~~
present invention will typically have a particle size up to about 300 microns, and will preferably be from 100 to

250 microns in size. These polymer powders can be made by usual techniques, such as cryogenic grinding.

Equipment for carrying out electrostatic spray coating and its general operation is known.

A general procedure for the process according to the present invention is as follows. A hollow object, e.g. glass bottle, maintained at a temperature below 100 °C, is placed into an electrostatic spray booth without pre-heating. In the spray booth, a steel rod in the inside the bottle, thereby establishing an electrostatic potential between powder to be applied to the bottle and bottle. The powder is electrically charged and applied to the bottle in a uniform manner. The bottle is then placed either in an oven (conventional or IR, according to the example followed) to melt the polymer powder. The IR oven will be configured to permit the optimum wavelength absorbed by the polymer used and may be equipped with ventilation to avoid high temperatures. Subsequently, the bottle is passed to an air cooling step and is cooled to room temperature.

The coating applied to the object will generally have a thickness up to 200 microns, preferably from 80 to 150 microns.

Examples

- Ionomer 1: ethylene methacrylic acid copolymer (EMAA)-Neutralised Na - 10% MAA
MFI (190 °C/2.16kg)=10
- Ionomer 2: Copolymer EMAA-Neutralised Zn-10% MAA
MFI=30
- Acid Copolymer 1: Copolymer EMAA - 15% MAA
MFI=60

Conventional oven: gas operated hot air oven, make Glasbeek, having the dimensions : 17x3x50m with a built in conveyor belt forming 4 serpentes.

Example 1

A lightweight 1 liter glass bottle (weight 415 g), maintained at 23 °C, and into which a steel rod making contact with glass is inserted, is electrostatically sprayed with ionomer 1 powder (particle size up to 225 micron).

The bottle is put, top down and rotating at 15 rpm between four Elstein IR 2000 elements, two being locate on each side of the bottle. The bottom of bottle is heated with a fifth Elstein IR element. The distance between elements and bottle is 6 cm.

The surface temperature of the elements is set at 722 °C, which creates the preferentially absorbed wavelength for this ionomer type:

The powder becomes a complete smooth melt in seven minutes. During cooling in ambient air no signifi-

cant haze is observed. The coating thickness is between 120 and 160 microns

Example 2

Example 1 is repeated with acid copolymer 1 powder (particle size 0-275 micron). Despite a higher MFI, it requires 12 minutes to achieve good coating. Upon cooling, haziness is observed.

Example 3

Example 1 is repeated with ionomer 2 (particle size 75-275 micron). No haziness after cooling, 6 min 30 seconds until flow-out, low orange peel.

Control - Conventional oven

A bottle is coated according to Example 3, with the exception that a convention oven is used in place of the IR elements. There is a heating time of 15 minutes to reach 210 °C, flow out takes 10 minutes and a further 10 minutes is required for cooling. The coating thickness is between 200 and 260 microns.

Claims

1. A process for forming a coating of a thermoplastic polymer on a hollow object formed of a low electrically conductive material, characterised in that the thermoplastic polymer has its maximum IR absorption between 1300 and 1900 nm and/or 2800 and 3000 nm, is applied electrostatically as a powder to the object while the object is held at a temperature below the melting point of the thermoplastic polymer, and thereafter the object is heated by IR radiation to form the coating.
2. A process according to claim 1 wherein the polymer is a copolymer of ethylene and an olefinically unsaturated organic acid, contains from 1 to 50 weight % of unsaturated monocarboxylic acids and is optionally neutralised up to 80% with at least one metal ion chosen from the 1st, 2nd or 3rd group of the periodic table.
3. A process according to claim 1 wherein the polymer is a copolymer of ethylene and 5 to 25% by weight acrylic or methacrylic acid neutralized from 5 to 60% with an alkali metal ion selected from the group consisting of sodium, potassium or zinc.
4. A process according to claim 2 wherein the copolymer further contains between 1 and 40 weight % of at least one acrylate selected from the group consisting of methylacrylate, iso-butylacrylate, n-butylacrylate and ethylacrylate.
5. A process according to claim 1 wherein the low

electrically conductive material is glass.

6. A process according to claim 1 wherein the hollow object is at a temperature below 100 °C at the time the thermoplastic resin is applied.

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7. A process according to claim 1 wherein the thermoplastic polymer powder has a particle size of up to 300 microns.

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8. A process according to claim 1 wherein the coating has a thickness of up to 200 microns.

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EUROPEAN SEARCH REPORT

Application Number
EP 96 20 0844

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	EP-A-0 667 381 (CIBA GEIGY AG) 16 August 1995 * page 10, line 25 - page 11, line 30 * ---	1	B05D1/06 C03C17/32 C03C17/00
A	US-A-5 338 578 (LEACH BURR L) 16 August 1994 * the whole document * ---	1	
A	FR-A-2 638 663 (LUMPP CHRISTIAN ; FRANCE RAYONNEMENT (FR)) 11 May 1990 * the whole document * ---	1	
A	EP-A-0 285 572 (SIV SOC ITALIANA VETRO) 5 October 1988 * column 4, line 30 - line 59 * -----	1	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			C03C B05D
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 31 July 1996	Examiner Brothier, J-A
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons A : member of the same patent family corresponding document</p>			

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